4

PRIMARY METHODS FOR COMPENSABLE VALUE DETERMINATION

4.1 INTRODUCTION

The second component of a claim for natural resource damages is compensation of the public for the interim loss of the injured resources' services. The monetized value of the interim lost services is known as "compensable value." Compensable values can be estimated in a number of ways, depending on the specific characteristics of the damage assessment. In certain cases, the results of existing research can be applied. This technique, referred to as "benefits transfer," is addressed in the next chapter. In other instances, primary studies may be required.[1] The range of primary techniques that can be applied to estimate compensable values, as identified in the DOI and NOAA rules, is the subject of this chapter.

The purpose of this chapter is not to provide step-by-step instructions for the conduct of primary economic studies. Rather, this chapter provides field staff who have little or no formal training in economics with a basic understanding of economic tools that may be applied in damage assessment. More specifically, this chapter:

- Provides guidance for conducting primary studies in simple assessments;

- Provides a general understanding of more complex valuation methods to allow field staff to conduct assessment planning and management activities for more complex cases; and

- Enables field staff to recognize the potential for claims based on various valuation approaches.

In addition, a better understanding of these techniques will help Service staff in drawing on the results of these types of studies in the context of benefits transfer.

The remainder of this chapter is organized into eight sections. Section 4.2 provides an overview of certain key economic concepts and links these concepts to the valuation techniques

[1] Primary studies involve collection of original data, and/or development of a model or valuation function specific to the case at hand.

described in this chapter. Sections 4.3 through 4.8 address each of the techniques individually, in the following order:

- Section 4.3: Market-based approaches (e.g., market price)
- Section 4.4: Added or Averted Cost
- Section 4.5: Revealed Preference
- Section 4.6: Factor Income
- Section 4.7: Contingent Valuation
- Section 4.8: Habitat Equivalency

Each of these sections includes a non-technical explanation of the technique, including a description of the data requirements, examples of ways in which it has been/could be applied in a damage assessment, and a discussion of its advantages and disadvantages.

Typically, no one method will capture all categories of economic damage resulting from a release event. Thus, multiple methods are often utilized. In cases where more than one method is applied there is the potential for double counting. The extent to which double counting may occur will depend on the methods used as well as case-specific factors (e.g., the extent of the market for a recreational opportunity). The last section of this chapter, Section 4.9, describes how to identify and eliminate double counting.

4.2 Overview of Economic Valuation

4.2.1 The Concept of Consumer Surplus

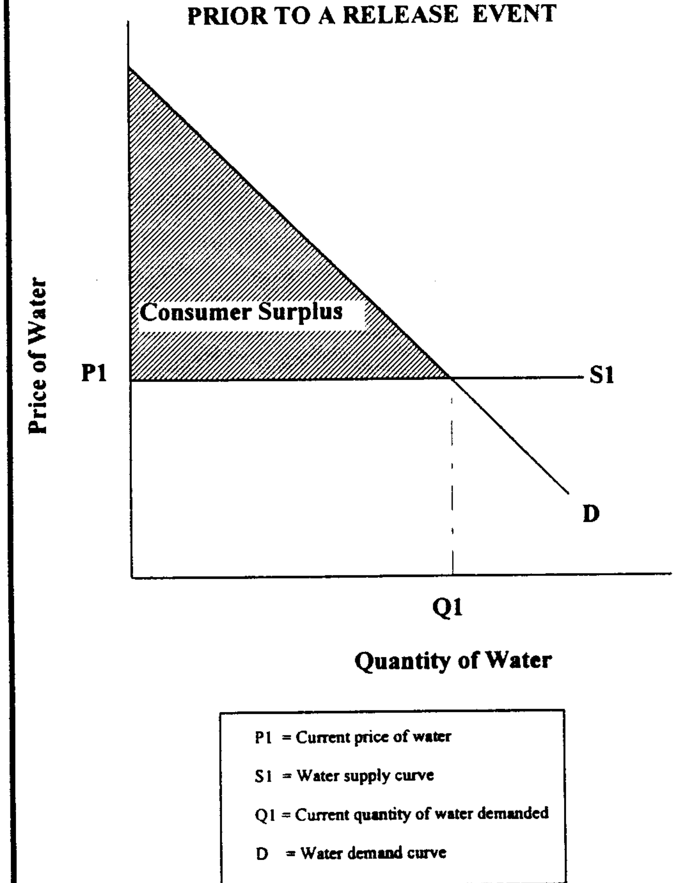
DOI's and NOAA's rules for damage assessment state that economic damages should be measured, in most cases, by a reduction in consumer and producer surplus. The concept of consumer surplus is based on the principle that some consumers benefit at current prices because they are able to purchase goods (or services) at a price that is less than the amount they are willing to pay for the good. If prices increase, the difference between prices and willingness to pay decreases, and thus utility derived from consuming the good decreases. Producer surplus reflects the fact that some producers would be willing to sell a good at a price that is less than the prevailing price in the market. The use of consumer surplus as a measure of overall economic welfare is widely accepted in economics.

When many individuals think of "economic damages" resulting from a release event, they focus on how common measures of economic activity, such as jobs or business revenues, have changed in response to the event. While these measures of economic impact may be important at the local or regional level, they do not necessarily represent net "societal losses," the appropriate measure of damages. For example, an oil spill might cause a decrease in tourism revenues in the immediate area of a spill; however, this decrease may be offset by increases in revenues at other locations. Total social welfare measures of economic damage (i.e., market-wide reductions in producer and consumer surplus associated with a natural resource and the services provided by that resource) take such substitution effects into account in estimating economic impacts.

The concept of consumer surplus is most easily understood through an example. Assume that a city receives most of its potable water from a lake that has recently been contaminated by a chemical spill. Exhibit 4-1 represents the market for potable water prior to contamination. The downward sloping demand curve (D) indicates the quantities of water demanded at different prices. As indicated by the slope of this curve, the quantity of water demanded is likely to decrease as price rises.

Exhibit 4-1

WATER SUPPLY AND DEMAND PRIOR TO A RELEASE EVENT



The horizontal line (at P1) indicates the current price of water. If the marginal costs of production are constant (i.e., the water utility's costs per unit supplied are constant), this line also represents the supply curve (S1). The intersection of the supply and demand curves represents the amount of water consumed (Q1) prior to the release event. The shaded area above the supply curve but below the demand curve represents the consumer surplus that accrues at the current price -- because some consumers' willingness to pay exceeds the price of the good.

Exhibit 4-2 indicates what happens to consumer surplus when the price (cost) of water increases due to the higher costs of substituting an alternative clean supply for the contaminated supply. The supply curve shifts upwards from S1 to S2, reflecting an increase in supply costs, and thus price. This change in price reduces both the quantity of water consumed and consumers' surplus. The loss in consumers' surplus is equal to the shaded area bounded by the two supply curves (S1 and S2) and the demand curve. This area represents a societal loss resulting from the contamination event. In other words, it represents the amount that the public has a right to be compensated for, or the "compensable value" component of the damage claim.[2]

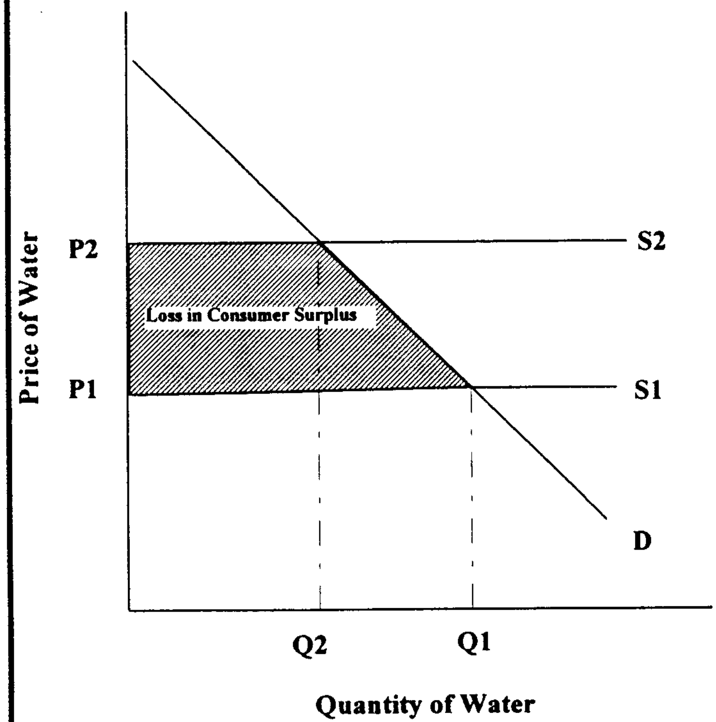
[12] In addition, as noted in Chapter 1, many claims will also include a restoration cost component.

4.2.2 Methods for Estimating Compensable Values

Economists have developed a variety of techniques to estimate societal losses resulting from reductions in environmental services. Exhibit 4-3 provides an overview of how certain economic methods can be used to value lost services. The first two columns of this exhibit present example categories of injury and lost services. The final column lists the valuation technique most commonly applied to value these lost services.[3] The economic methods listed in this table are described below.

Exhibit 4-2

LOSS IN CONSUMER SURPLUS FOLLOWING A RELEASE EVENT



P1 = Price of water before contamination
P2 = Price of water after contamination
S1 = Water supply curve before contamination
S2 = Water supply curve after contamination
Q1 = Quantity of water demanded before contamination
Q2 = Quantity of water demanded after contamination
D = Water demand curve

When goods and services are traded in the marketplace, economic losses can be estimated through an analysis of market behavior. These market-based techniques, and the circumstances under which they apply, are the subject of Section 4.3. In general, however, formal markets do not exist for the vast majority of public resources and services being analyzed within a damage assessment. As a result, compensable values must be indirectly derived by examining behavior in related markets (e.g., the housing market), or directly derived (e.g., the application of survey research techniques within a contingent valuation).

Indirect valuation methods infer environmental values by closely examining behavioral changes that result from release events. Indirect methods that focus on *substitutes* for environmental quality are generally referred to as analyses of averting behavior (see Section 4.4). Such studies look at willingness to pay to mitigate or avoid the effects of a release to infer the value placed on the damage. For example, expenditures on drinking water treatment can be used to estimate the value of changes in ground or surface water quality.

Alternatively, activities that are *complements* to environmental quality can be analyzed to infer damages resulting from a release event. These approaches, often referred to as "revealed

[3] The valuation methods listed in this table are common examples, and do not span the universe of possible options.

Exhibit 4-3

CATEGORIES OF INJURED RESOURCES, LOST SERVICES, AND COMMON VALUATION TECHNIQUES

Example Categories of Injured Resources*	Example Lost Services **	Common Valuation Techniques
Habitat (e.g., wetland, forested upland, grassland, riverine systems, coastal systems, sediments, coral reef)	Services provided to other resources, such as: clean water, sediments, soils, and food. Passive use ***	Market-based (e.g., appraisal) Factor Income Contingent Valuation
Fish and Wildlife	Endangered species Passive use	Habitat Equivalency Contingent Valuation
National Parks, National Wildlife Refuges, National Monuments, other public lands	Habitat Recreation Education Preservation Cultural Passive Use	Market-based (e.g., fee losses) Revealed Preference Contingent Valuation
Beaches, Rivers, Surface Water Bodies, Marine Corridors, Wetlands	Water quality Commercial use (e.g., municipal/ industrial/agricultural water supply; marine transport; economic development) Recreational use (e.g., swimming, fishing, hunting, wildlife viewing) Subsistence use Flood control/erosion prevention Education Research Passive use	Market-based Added Cost Revealed Preference Contingent Valuation Habitat Equivalence
Groundwater	Municipal/commercial/industrial/ agricultural use Discharge of clean groundwater to surface water Passive use	Market-based Added Cost Contingent Valuation
Archaeological and Cultural	Education Research Passive use	Revealed Preference Contingent Valuation

* The categories listed in this exhibit are not mutually exclusive (i.e., a release event may result in injury to multiple resource categories, as well as a range of lost services).
** The services provided by a natural resource can accrue to humans and to other natural resources, and need not be consumptive.
*** As used here, the term "passive use" incorporates values referred to by NOAA and DOI as "non-use" and "passive use" values, and by others as "existence" and "preservation" values.

preference" techniques, are addressed in Section 4.5. For example, if clean surface water is associated with increased recreational activity, then willingness to pay for recreational use can be used to indirectly estimate the value of clean water. For example, travel cost models, analyzing the recreational choices that individuals make and the distance these individuals are willing to travel to access recreational opportunities, can be used to value resources and the services they provide. Other revealed preference techniques examine goods that include environmental quality as one of several attributes. For example, property value studies can be used in certain circumstances to statistically separate the effects of local environmental quality from other factors affecting property price.

Another way of indirectly deriving resource value is to evaluate the resource and the services it provides as part of a "production" process. For example, a freshwater wetland might serve to improve water quality. This approach, known as the factor income method, is described in Section 4.6.

Direct valuation methods generally involve surveying individuals' willingness to pay for a specific change in environmental quality. Direct methods include contingent valuation, which uses surveys to collect relevant data, and related methods such as conjoint analysis and contingent ranking. As discussed in Section 4.7, the contingent valuation method can be used to estimate both direct and passive use values, and is the only method available for estimating passive use values.

Finally, society can be compensated for resource service losses through the provision of additional services of the same type in the future. For instance, if a certain acreage of wetland is affected by the release of oil over a finite period, the public may be directly compensated for these interim lost services via the provision of additional wetland acreage in the future (wetland acres provided as compensation for interim losses are *in addition* to those provided to restore or replace the injured resource). This approach, which avoids any attempts to monetize the value of lost services, is generally referred to as the habitat equivalency approach. Section 4.8 addresses this approach in some detail.

4.3 Market-Based Approaches

Compensable values may be estimated by examining markets for natural resources, in instances where such markets exist. In this section, we describe three market-based techniques: market demand and supply models, fee losses and appraisals.

4.3.1 Market Demand and Supply Models[4]

As indicated in DOI's and NOAA's rules, economic damages associated with some pollution discharge events may be estimated using market prices (43 CFR 11.83(c)(2)(i) and 15 CFR 990.78(b)(4), respectively). This technique is applicable when the injured natural resources, or some service they provide, are regularly traded in a competitive market. That is, the market must be characterized by several buyers and sellers and must not be constrained in any undue fashion. The correct measure of damages using this technique is the change in consumer surplus and economic rent associated with the resource as a result of the release event. Thus, the data generally required

[4] This methodology is referred to under "Marketed Resource Methodologies" in DOI's rule.

to implement this approach are the price and the quantity of the injured natural resources, or the services these resources provide, before and after the release event. These values can then be used to approximate the welfare loss associated with a release event.

In some cases it may be possible to apply a simplified market-based approach to estimate damage. For example, economic damages associated with the closure of a commercial fishery may be estimated using forecasts of expected commercial harvest levels and market prices in the absence of the release event. That is, if the impact of the event is limited in geographic scope and duration, economic damages may be approximated by the quantity of fish not harvested (i.e., catch foregone as a result of the event) multiplied by the market price of the species in question. The same approach can be applied to estimate damages resulting from a reduction in fish abundance, and thus a change in commercial fish harvest following a release event, in cases where the effect is of limited duration and extent.[5]

For large scale changes in regional catch rate, or for effects which continue for an extended period of time, a market price approach may not be appropriate, however. Specifically, a number of assumptions must be made to apply a simplified market price approach to estimate damages associated with a commercial fishing closure. For example, the release cannot lead to a large change in market price or to a long-term change in commercial fishing effort. If either of these assumptions does not hold, application of a simplified market-based approach may not be appropriate.

4.3.2 Fee Losses

Another component of compensable values under DOI's and NOAA's rules is losses in fees or payments made to federal or state agencies or Indian tribes by individuals or firms for the use of natural resources [43 CFR 11.83(c)(1)] and [15 CFR 990.77(h)(1)(ii)]. While not specifically identified as such, this approach is implicitly a market-based methodology, since fees represent prices that individuals or firms are willing to pay in the market.

To implement this method, trustees need to collect data on (1) the amount of the fee per unit of the good or service provided (e.g., per day) and (2) the number of units affected by the contamination event (e.g., persons per day). For example, assume that an oil spill affects a National Seashore, resulting in the closure of one portion of the seashore for eleven weeks during the summer while cleanup activities occur. The National Park Service charges a $5.00 entrance fee per car for access to the seashore. Based on a careful review of the three previous seasons' records, the trustees conclude that the number of trips to the seashore declined from what it would have been in the absence of the spill by 1,000 cars per week, or 11,000 in total over the eleven weeks that the beach was closed. Compensable values in this case would include the loss in fees for access to the

[5] Other examples of resources that might be valued using the market price approach include fur bearing animals and water supplies (where markets for water exist).

seashore, equal to $55,000.[6] The use of this methodology is appropriate in all situations where fees are typically collected for use of a resource affected by a release event.[7]

4.3.3 Appraisal Methodology

In certain cases, a change in the appraised value of a natural resource (or the services the resource provides) can be used as a proxy for compensable value. The measure of damages under this method is the difference between the appraised value of the resource with and without injury. The appraisal method is specifically listed as an option under DOI's rule [43 CFR 11.83(c)(2)(ii)], and is identified under the "market models" section of NOAA's proposed rule [15 CFR 990.78(b)(4)(ii)].

As with other market-based methods, this approach should only be applied when a well-defined market for the resource exists. In addition, its use is limited to those resources for which standard appraisal methods exist. For instance, remediation activities at a site might result in the loss of an area of commercial timberland. The appraised value of this timberland, both pre- and post-injury, could serve as a proxy for economic damage.

4.4 Added or Averted Cost

A release event may impose added costs on users of the affected resource. These added costs represent one measure of societal losses resulting from a release event. For example, following an oil spill it may be necessary to temporarily close a harbor or waterway to commercial shipping in order to undertake cleanup activities. In these cases the added cost of marine transportation, resulting from added shipping distances or delays in shipping, can be used as a measure of economic damage. Similarly, closure of a popular commercial fishing ground may result in commercial anglers incurring the added cost of motoring to alternative fishing sites.[8]

In many cases the data required to estimate damages using this technique, which include the cost of the affected activity pre- and post-release, will be readily available. Where site-specific data are not available, it may be possible to apply generic estimates. For example, experts within the U.S. Coast Guard or with private firms can provide general estimates of the hourly cost of operating commercial vessels.

This approach was recently applied to develop a preliminary damage estimate at a contaminated municipal water wellfield. Per-household data on the cost of tap water and the cost of bottled water were collected, as was an estimate of the impact of price changes on the demand for

[6] Note that these lost fees may not fully reflect damages if visitors were willing to pay more for entrance to the site than was charged (i.e., there were consumer surpluses associated with use of the site).

[7] An alternative technique would be to use a simple site demand model which predicts demand given weather, time of year, etc.

[8] Both of the examples rely on measures of economic rent for estimating damages, as discussed in Chapter 1.

drinking water. These data were combined to estimate the loss in consumer surplus from switching from tap to bottled water in response to a contamination event. The estimated loss in consumer surplus was approximately $20 per-household per-month. By combining this figure with information on the number of households affected (approximately 2,000) and the number of months they were affected (24), compensable values were estimated to be approximately $1.0 million.

The principal strength of the averted cost method is that it is based on actual behavioral responses to a release event. Further, the approach is conceptually and practically straightforward. One drawback of this method is that actions taken which generate averted costs may not be exact substitutes for the activity or service affected by the release event. For example, bottled water and city water may not be exact substitutes, due to differences in taste. Bottled water purchases may provide the consumer with additional benefits beyond the avoidance of real or perceived risks associated with a contaminated water supply. Such additional benefits should be subtracted from the interim losses claimed as compensable values.

4.5 Revealed Preference

A range of valuation techniques exist under the general category of revealed preference. Revealed preference approaches are indirect methods premised on the assumption that compensable values can be estimated based on careful observation of individual behavior in response to a release event. For example, beach visitation may decline at a spill site following an oil spill event, while increasing at substitute sites. In the simplest case the added cost incurred by beach users in traveling to a substitute site can be used as a measure of economic damages. Revealed preference techniques that have been applied in natural resource damage assessment include travel cost models, random utility models, and repeat sale and hedonic property valuation models.[9] Examples of revealed preference approaches are included in the case studies which are appendices to this manual.

4.5.1 Travel Cost Models

Travel cost models are analytical tools frequently applied to value access to recreational opportunities, as well as to value changes in quality characteristics of these recreation opportunities. Basic travel cost models for a single site are based on the concept that the value of a recreation site can be estimated by analyzing the travel and time costs incurred by individuals in visiting the same site or an alternate site. Given a release event that changes the quality of a site (e.g., a fishery closure following an oil spill), one might expect to see a change in willingness to pay for the site, expressed as a reduction in the willingness to incur travel and time costs to access the site (or a willingness to incur additional travel and time costs to access a substitute site). In addition to simple travel cost models, researchers have also developed random utility (or discrete choice) models where the decisions to visit a particular site are evaluated as a function of the characteristics of available sites. The travel cost approach is specifically identified in both the DOI and NOAA rules [43 CFR 11.83(c)(2)(iv) and 15 CFR 990.78(b)(1)].

[9] While this chapter focuses on methods that have been applied in a wide-range of settings, other revealed preference techniques may be appropriate in certain circumstances.

Travel cost approaches require data on site visitation, which are often available from a range of local, state and federal resource management agencies. In certain cases, formal or informal site-specific surveys may need to be conducted. For example, a random utility model of fishing behavior was developed by the State of Montana for the Clark Fork River damage assessment (Morey and Rowe 1995). Fish populations in the Clark Fork River have been affected by the release of metals attributable to past mining activities. The model developed for this site predicts how many trips anglers take in southwestern Montana as a function of trip costs, expected catch rates, size of sites, and characteristics of the angler, such as gender, age, skill level and amount of free time. To develop this model, 443 Montana anglers were interviewed. The results of these interviews allowed the authors to estimate how angler behavior had been influenced by a lower than expected catch rate on the Clark Fork River. These behavioral changes (e.g., traveling farther to access a substitute site or taking fewer fishing trips altogether) represent damages resulting from injuries to the Clark Fork River fishery.

Travel cost approaches are limited by the quality of the underlying behavioral data, including the availability of data on substitute recreation opportunities. In addition, travel cost approaches are limited in their ability to measure small changes in the quality of a site.[10] However, in cases where the change in services provided by a site is obvious (e.g., a recreational fishing closure), and where sufficient data are available, these methods have the potential to provide highly defensible damage estimates.

4.5.2 Property Valuation Models

Property valuation models assess how proximity to various environmental amenities (e.g., a bathing beach) or disamenities (e.g., the site of a release event) influence the amount individuals are willing to pay for real property. There is no disagreement that location is an important factor in the value of residential and commercial property. For example, it is well understood that a house will sell for more or less depending on the attributes of the neighborhood in which it is located. While there is some disagreement as to the magnitude of the effect, most economists would agree with the premise that long-term damage to environmental resources, such as reductions in the quality of a beach or coastal wetland, could act to reduce nearby property values. Thus, this method uses changes in property values as a proxy for changes in nearby resource values.

Two principal methods have been used in the damage assessment context: the hedonic property valuation approach and the repeat sales approach. Hedonic property valuation involves the use of cross-sectional data on home characteristics for a range of homes in a given area at one point in time (e.g., data on lot size, number of bedrooms, or presence of a municipal landfill). Statistical regression analysis is then used to determine the contribution of each factor to sale price. Hedonic analyses have been conducted at the house-level, using data on individual properties, and at the regional level, using data on average home characteristics across towns and counties. This approach is specifically identified in the DOI and NOAA rules [43 CFR 11.83(c)(2)(v) and 15 CFR 11.78(b)(3)]. Repeat sale analysis, or panel data analysis, considers the relative rates of change in housing prices between affected and control (unaffected) areas. (Panel models follow a fixed sample

[10] For a fuller discussion of limitations of travel cost methods, see Randall 1994.

of homes through time.) For example, comparing the rates of home appreciation before and after a release event and between affected and unaffected areas would yield a measure of property value impacts. Repeat sale studies are particularly useful in cases where individual property characteristics data are not available.

For example, the property valuation approach was applied by NOAA to evaluate the reduction in the amenity services provided by New Bedford Harbor in Massachusetts, resulting from PCB contamination of the harbor (Mendelsohn 1992). A repeat sales model was developed to determine if the value of homes located near the harbor had been affected by the announcement that the harbor was contaminated with PCBs. Data collected for this analysis included sale prices for single family homes located within two miles of the New Bedford Harbor shoreline that sold at least twice between 1969 and 1985. Data on any improvements or renovations, which could increase home value, were also collected. To separate out the effect of the PCB contamination on home prices, a number of other factors that affect housing prices were controlled for, including inflation, interest rates, neighborhood characteristics, proximity to the harbor, and the length of time between sales. Using sophisticated regression analysis techniques, this analysis found that homes located within two miles of the harbor experienced property value changes that were 12 percent less than other properties in this area. The total damages resulting from this decline in harbor amenities was estimated to be between $26.2 million and $39.0 million dollars.

A fundamental advantage of the property valuation technique is that a reduction in property values can serve as a measure of many lost services associated with a change in environmental quality. Further, the method is based on observable behavior in a market that is well understood. There are a number of limitations associated with this approach, however. The most significant of these limitations include:

- Hedonic and repeat sales models require a large amount of relatively detailed data. In some cases sufficient data will not be available to implement this technique.

- Given the large number of factors that determine home value, it is often difficult to disentangle the influence of various factors; for example, it may be difficult to separate out the effects of a release of a hazardous substance from a uncontrolled hazardous waste site from the effects of the aesthetic impacts of the site.

- The ability of hedonic or repeat sales models to detect small changes in resource attributes is limited because a large number of factors act together to determine market price, some of which may correlate with the effect in question.

- These methods may result in damage estimates that double count other categories of damages, such as lost recreation opportunities. This issue is addressed further in Section 4.9.

Property valuation models are most appropriately applied at sites where the contamination event has a long duration. For instance, property valuation techniques are generally more relevant in the context of hazardous waste sites than oil spills, whose effects tend to be more transient in nature.

In addition, to separate the many influences on property values, the affected service flows must also be thought to have a strong link with property values.

4.6 Factor Income Methodology

Under the factor income approach, the services provided by the injured resource are viewed as inputs to the production of a service or commodity sold in the market. This approach is based on the economic concept of a production function; that is, inputs such as natural resources are combined to produce a good or service sold in the market. Changes in the cost of acquiring these inputs can serve as the basis for estimating damages. For instance, a reduction in the abundance of lower order aquatic species may increase the cost of acquiring a commercially valuable fish species, as the lower order species may serve as an important source of food for the commercially valuable species. As a result, the economic rent accruing to the producer from the use of the resource may diminish. The change in economic rent may be evaluated by calculating the change in surplus in either the final product or input markets. Similar approaches may be feasible in cases in which important recreational service flows are affected (e.g., bird viewing opportunities). The factor income approach is explicitly identified in both the DOI final and NOAA proposed rules [43 CFR 11.83(c)(2)(iii) and 15 CFR 11.78(b)(2)].

The factor income approach should only be applied in settings where the primary value of the injured resource affects the cost of producing (or harvesting) a more highly valued resource. Using this method to measure damages accurately requires a thorough understanding of the inputs in the production process, and how changes in these inputs affect production costs. In some cases, information on factor inputs simply will not lead to the generation of damage estimates that can withstand the scrutiny typically encountered in a litigation setting.

4.7 Contingent Valuation

The contingent valuation (CV) method uses survey techniques to directly elicit information on individuals' willingness to pay for goods that are not commonly traded in markets, such as natural resources and the services they provide. Components of this approach include developing a contingent market that provides survey respondents with a description of the good or service being valued, developing the institutional framework under which the good would be provided, creating a hypothetical payment vehicle, and providing respondents with an opportunity to express a value for the good or affected service. Both the DOI and NOAA rules specifically approve of the use of this method to assess the use value for a hunting or fishing day, or to better understand changes in beach use. Similarly, CV can be applied to estimate losses in passive use values resulting from oil spill events. The CV methodology is listed as a valid assessment technique in both the DOI and NOAA rules [43 CFR 11.83(c)(2)(viii) and 15 CFR 990.78(b)(5)], although DOI has not promulgated final regulations guiding the use of the technique. In addition to the CV method, related techniques such as contingent behavior, contingent ranking and conjoint analysis have been applied to directly elicit information on willingness to pay. The principal concept behind these approaches is the creation of a hypothetical market similar to the more widely utilized CV method.

The development of a full-scale CV study generally involves several stages. These include:

- Developing a preliminary survey instrument;
- Conducting focus groups to gauge the public's knowledge of the good or service being valued;
- Conducting one-on-one interviews to pretest the survey instrument;
- Implementing a pilot field test of the instrument;
- Implementing the final survey; and
- Analyzing the information obtained from the pilot and final surveys.

This multi-step process is designed to reduce biases that may be created by a poorly designed or administered survey.

The advantage of the CV method is that it can be used to capture the full range of values affected by a contamination event. In addition, because this method relies on stated values rather than observed behavior, it is the only method available for many service flows, including both direct use and passive use (e.g., in cases in which there are no behavioral data available to characterize demand for baseline conditions of the environment). However, the reliability and validity of this method has been the subject of much recent controversy. Some economists express particular concern about the ability of the method to provide meaningful estimates of passive use values for public goods.[11] The debate focuses largely on whether respondents can provide reliable estimates of the value of these types of goods, given that the public has little or no experience with purchasing such goods. Other criticisms are that respondents stated intentions may not equal true willingness to pay and that respondents are affected by the "warm glow" of giving, which influences their willingness to pay responses.

Due to the importance of the method in many damage assessments, a panel of eminent economists was convened by the National Oceanic and Atmospheric Administration (NOAA) to evaluate whether the CV method should be applied to estimate lost passive use values for the purposes of damage assessment. The panel concluded that "contingent valuation studies can produce estimates reliable enough to be the starting point of a judicial process of damage assessment, including lost passive-use values," if the studies follow a series of relatively stringent guidelines.

[11] Many economists believe that this method is appropriate for estimating the use values associated with a resource or change in environmental quality.

The NOAA Panel

In 1992, NOAA commissioned a panel of economists and other experts to review the CV method and its application for measurement of passive use values. Drawing on presentations at a public hearing, written statements submitted by interested parties, and examination of the existing CV literature, the panel concluded that CV studies convey useful information about the valuation of natural resources, provided that a number of conditions are met in the design, implementation, and interpretation of the CV survey [see 58 FR 4601-4614].

One fundamental issue addressed by the panel was the concern that a hypothetical market, when posed to survey respondents, yields results that are biased upward in comparison to the results of actual market transactions. The panel concluded that calibration of these results to adjust for the upward bias associated with the framing and/or order of questions is currently not possible. Therefore, as a general guideline, the panel urged practitioners of CV surveys to "lean in the conservative direction [in making key survey design decisions], as a partial or total offset to the likely tendency to exaggerate [willingness to pay]." Also as general guidelines, the panel stressed the importance of asking respondents to consider alternative uses of funds, and the importance of confirming that respondents take the proposed payment vehicle seriously.

The panel's report also provides specific recommendations relating to CV surveys. For example, the panel favored personal interview formats, either telephone or face-to-face, over mail surveys because of the greater representativeness and control afforded by personal interviews. They stated that, "mail surveys should be used only if another supplementary method can be employed to cross-validate the results on a random subsample of respondents." In addition, the panel recommended that a "referendum format" be used in CV surveys. The referendum format directs respondents to "vote" either for or against the plan outlined in the survey, as they would for a state or local political referendum. The panel believed that respondents find it extremely difficult to provide a dollar value for a good in a hypothetical market, and that other common methods such as payment cards introduce a bias into the process. To verify that individuals understand the implications of the referendum and evaluated the choice as intended, the panel recommended follow-up questions to determine why a "yes" or "no" vote was cast, and recommended probing of respondents' comprehension and acceptance of the scenario. The panel also pointed out the desirability of including a "no opinion" option.

Finally, the panel also proposed conditions that future CV studies should adopt, to the extent possible. For example, the panel believed that alternative expenditure possibilities should be presented to respondents, to convey an understanding of the finite resources available for public goods expenditures.

In addition to the NOAA panel report, several economists have written extensively on concerns related to the use of CV, as well as on procedures that can be used to address these concerns. For example, Mitchell and Carson (1989) provide a comprehensive list of issues to consider in designing a new study or considering the quality of an existing study. The issues relate primarily to four topics:

- **Sampling and Survey Administration Procedures** - A CV study should use generally accepted sampling and survey administration procedures designed to promote the reliability of the results. These procedures include the use of probability sampling, large sample sizes, focus groups and pretesting of the survey instrument, and methods to minimize non-response.

- **Description of Commodity and Market** - The survey should present the valuation scenario in a realistic and understandable fashion that will be accepted by the respondents. For example, a well-designed survey should provide an accurate description of the nature and relative magnitude of the problem being addressed and should include reminders of budget constraints and substitute commodities.

- **Value Elicitation** - The method used to elicit values should be designed to encourage respondents to provide meaningful values. For example, the NOAA panel believes that a referendum format (where respondents are asked whether they would be willing to pay a specified amount for the program) is preferable because it is similar to the familiar experience of voting.

- **Evidence of Validity and Reliability** - CV studies should also provide evidence that respondents understood and accepted the valuation scenario and that the results are unbiased. For example, follow-up questions can be used to probe responses, and researchers can test for potential biases and for internal consistency.

Over the past two decades, numerous CV studies have been conducted to elicit willingness-to-pay values for environmental improvements. These surveys have generally implemented some, but rarely all, of the NOAA panel recommendations. A few recent studies, such as the study conducted by the State of Alaska for the *Exxon Valdez* oil spill and the study conducted for the Southern California Bight damage assessment, have met most, if not all, relevant criteria (Carson, et al. 1992).

As mentioned earlier, CV is the one method available for estimating passive use values. As a result, this technique serves an important function at sites where passive use losses are thought to be large in scale. One disadvantage of the approach is that the cost of conducting state-of-the-art CV research that is likely to stand up to the scrutiny typically encountered in a litigation setting can be quite high. For example, to develop, implement, and defend a full-scale CV survey of an oil spill could require funding of $500,000 to several million dollars. Thus, application of this method is likely to be appropriate only for very large-scale events. While less costly studies have been (and continue to be) performed, these studies generally do not meet the requirements outlined by the NOAA panel and other authorities.

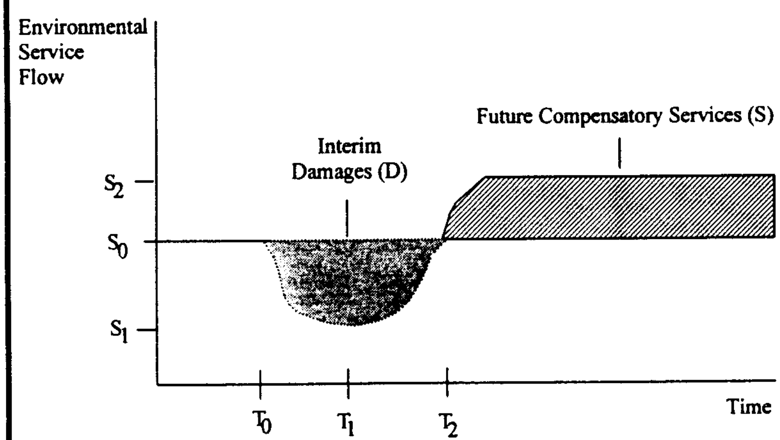
4.8 HABITAT EQUIVALENCY

The basic premise of the habitat equivalency approach is that the public can be compensated for interim losses in services through the provision of additional services of the same type in the future. These services are in addition to those provided to restore the resource to baseline conditions; they are meant to compensate for interim losses. The unique aspect of this approach is that the measure of compensable values is not dollars, but rather the diminished service itself. For instance, the public can be compensated for injuries to wetlands through the provision of additional "wetland acre years," in the future to account for the interim loss of wetland services.[12] The habitat equivalency method is not explicitly included in the DOI rule, but is included in NOAA's proposed rule [15 CFR 990.78(c)(2)], and could be considered within "other valuation methodologies" under DOI's rule.

The conceptual framework for the habitat equivalency method is illustrated in Exhibit 4-4. At time T_0, a resource has been injured as a result of a hazardous substance release, reducing the flow of service from the resource from S_0 to S_1. Upon restoration of the resource at time T_2, these services have been restored, although compensable values, identified in this figure as interim damages (D), remain. If the magnitude of this loss in service flow can be measured, it is possible to estimate a flow of services in the future (represented in the graph as area S) that will be equivalent to area D.

Exhibit 4-4

CONCEPTUAL BASIS OF THE HABITAT EQUIVALENCY METHOD



Since the habitat equivalency approach can be applied in assessments without conducting primary economic analysis, a detailed example of the approach is provided in this section.[13] As illustrated in Exhibit 4-5, assume a hazardous substance release reduces annual fish populations by 100 fish, starting in 1985. That is, scientists determined that there would be 100 fewer fish in the affected ecosystem each year from 1985 through 1999. This loss is shown in the column labeled "Loss in Services." Note that this example assumes the recovery of damages from the responsible party in 1995, but that interim losses will continue until 1999.

[12] See Unsworth and Bishop 1994 and R2 Resources (1995) for examples of the application of this technique to damage assessment. The habitat equivalency approach is also referred to as the "environmental annuities" approach and the "biological equivalency" approach.

[13] Note, however, that application of this method may require primary scientific investigations. In addition, service field personnel applying this technique should request review of all calculations performed by the Division of Economics.

The third column of this exhibit reflects concepts known as compounding and discounting, as discussed in more detail in Chapter 6 of this manual. These concepts have much in common with the notion of interest, and are analogous to financial calculations made every day by individuals and businesses. For example, imagine a case in which an individual was to have received $100 per year from 1985 until 1999, but for some reason was not provided these payments. Those payments, if paid in one lump sum today (i.e., in 1995), would be worth $1,652, assuming a three percent rate of return on the annual payments. That is, the individual would be as well off financially between having received $100 each year from 1985 to 1999 and receiving $1,652 today. For example, in order to make the individual equally well-off today for the first payment that was missed in 1985, the individual would need $134 today. Similarly, anindividual would be willing to accept $89 dollars today instead of $100 in 1999, since this individual could invest and earn interest on the $89 from 1995 until 1999.

Exhibit 4-5

AN EXAMPLE CALCULATION OF THE PRESENT VALUE OF PAST LOSSES

Event	Year	Loss in Services (Fish)	Discount Calculation[1]	Present Value Loss (fish)
Release of Hazardous Substance	1985	100	$* (1 + 0.03)^{1995-1985} =$	134
	1986	100	$* (1 + 0.03)^{1995-1986} =$	130
	1987	100	$* (1 + 0.03)^{1995-1987} =$	127
	1988	100	$* (1 + 0.03)^{1995-1988} =$	123
	1989	100	$* (1 + 0.03)^{1995-1989} =$	119
	1990	100	$* (1 + 0.03)^{1995-1990} =$	116
	1991	100	$* (1 + 0.03)^{1995-1991} =$	113
	1992	100	$* (1 + 0.03)^{1995-1992} =$	109
	1993	100	$* (1 + 0.03)^{1995-1993} =$	106
	1994	100	$* (1 + 0.03)^{1995-1994} =$	103
Recovery of Damages	1995	100	$* (1 + 0.03)^{1995-1995} =$	100
	1996	100	$* (1 + 0.03)^{1995-1996} =$	97
	1997	100	$* (1 + 0.03)^{1995-1997} =$	94
	1998	100	$* (1 + 0.03)^{1995-1998} =$	92
	1999	100	$* (1 + 0.03)^{1995-1999} =$	89
TOTAL PRESENT VALUE LOST SERVICES				1,652

[1] Example assumes a three percent discount rate.

As shown, losses that occurred in the more distant past have a greater value today than losses that occurred more recently. For example, the present value of 100 fish lost in 1985 is 134 (assuming a three percent discount rate), while the present value of 100 fish lost in 1993 is 106. This is simply due to the fact that the earlier losses are being compounded over a greater period of time. Similarly, losses that occur in the future have a smaller present value than the same losses that occur today.

The total present value of the loss in this example is 1,652 present value fish years, where a "fish" is the provision of one fish for one year.[14]

In order to make the public whole, it will be necessary to provide a flow of services (in this example, fish) in the future with the same present value as the present value loss. In this simple example, the appropriate equivalent service flow is the 1,652 fish calculated in Exhibit 4-4. Using a computer spreadsheet, it is possible to determine that approximately 50 additional fish per year are needed in perpetuity to make the public whole for their interim loss.

The last column of Exhibit 4-6 presents the present value of a service flow (in this example, 50 fish), provided each year in perpetuity, with a present value equivalent to the loss. As shown, the present value of 50 fish provided in the year 1997 is approximately 47; the present value in 2075 is approximately five; and by 2148 the present value of this service flow has fallen to nearly zero. The present value of 50 additional fish provided in perpetuity is approximately 1,652.

In summary, the principle steps for a habitat equivalency analysis are:

1. Select a metric by which natural resource injury at the site is to be measured (e.g., wetland acres lost, fish population decline, beach days lost).

2. Estimate the reduction in units of that metric, each year, from the time of the release (or first year in which damages will be claimed through full resource recovery.

3. Calculate the present value of these compensable losses.

4. Select a period over which compensable resources or services will be provided (e.g., beginning in five years and extending for 20 years).

5. Calculate the number of units of additional resource or services required in each year of the compensation period, to generate a present value equivalent to that calculated in step 3.

6. Calculate the cost of providing these replacement resources or services. This calculation should be based on the most cost-effective replacement options available.

[14] The formula for calculating this figure is:

$$\sum_{t=d}^{R} N_t (1 + i)^{T-t}$$

where: d = year in which injury first occurred
R = year resource will be fully restored
N_t = number of units of resource in year t
i = real interest rate; and
T = current year.

Exhibit 4-6

AN EXAMPLE CALCULATION OF THE PRESENT VALUE OF COMPENSABLE SERVICES

Event	Year	Equivalent Services Restored (Fish)	Discount Calculation[1]	Present Value Compensation
Compensatory Restoration Starts	1994	0	-	0
	1995	0	-	0
	1996	50	$*(1+0.03)^{(1995-1996)}=$	49
	1997	50	$*(1+0.03)^{(1995-1997)}=$	47
	1998	50	$*(1+0.03)^{(1995-1998)}=$	46
	1999	50	$*(1+0.03)^{(1995-1999)}=$	44
	2000	50	$*(1+0.03)^{(1995-2000)}=$	43
	2001	50	$*(1+0.03)^{(1995-2001)}=$	42
	2002	50	$*(1+0.03)^{(1995-2002)}=$	41
	2003	50	$*(1+0.03)^{(1995-2003)}=$	39
	2004	50	$*(1+0.03)^{(1995-2004)}=$	38
	2005	50	$*(1+0.03)^{(1995-2005)}=$	37
	2006	50	$*(1+0.03)^{(1995-2006)}=$	36
	2007	50	$*(1+0.03)^{(1995-2007)}=$	35
	2008	50	$*(1+0.03)^{(1995-2008)}=$	34
	2009	50	$*(1+0.03)^{(1995-2009)}=$	33
	2010	50	$*(1+0.03)^{(1995-2010)}=$	32
	-	-	-	-
	-	-	-	-
	-	-	-	-
	2075	50	$*(1+0.03)^{(1995-2075)}=$	5
	2076	50	$*(1+0.03)^{(1995-2076)}=$	5
	2077	50	$*(1+0.03)^{(1995-2077)}=$	4
	-	-	-	-
	-	-	-	-
	-	-	-	-
	2148	50	$*(1+0.03)^{(1995-2148)}=$	1
	2149	50	$*(1+0.03)^{(1995-2149)}=$	1
	2150	50	$*(1+0.03)^{(1995-2150)}=$	1
	2151	50	$*(1+0.03)^{(1995-2151)}=$	0
TOTAL PRESENT VALUE COMPENSATION				1,652

[1]Example assumes a three percent discount rate.

The habitat equivalency approach can be used for a number of different service losses resulting from various kinds of injuries. The technique is most appropriate given one or more of the following circumstances. First, the extent of injury (e.g., number of birds killed, acres of wetland lost) and the duration of the injury should be well quantified. Second, since this technique involves the provision of additional resources of the type that were injured, replacement projects need to be feasible and commonly undertaken (e.g., fish enhancement projects, bird breeding, wetland conservation). The public will not be compensated using this approach if the replacement project fails to provide the appropriate quantity of additional resources. Third, the value of the resource should be roughly constant over the period of analysis (e.g., from the onset of injury through the replacement period). If the value of the resource is thought to change significantly over this period, the public may be either under- or over-compensated using this approach, unless an adjustment is made to the calculation to account for the change in the value of the resource over time.[15] Finally, in all cases the resources or services provided as compensation for the loss must be qualitatively equivalent to the resources and services that were lost due to the injury. If these services and resources are not equivalent, this method may over- or under-compensate the public for the compensable loss.

Case Study: Injury to Service-Owned Lands

During the 1960s the National Gypsum Corporation disposed of large volumes of asbestos waste in the Great Swamp of New Jersey. As a result, five acres of wetland were destroyed, and a larger area of the swamp became contaminated with asbestos and other hazardous substances. In 1968 the U.S. Fish and Wildlife Service purchased the disposal site as an addition to the Great Swamp National Wildlife Refuge. In 1988 the site was added to the Superfund National Priorities List. In 1990, however, facing claims associated with a class action suit brought by individuals exposed to asbestos, the National Gypsum Company declared bankruptcy. As a result, DOI was forced to file a claim for damages to natural resources under very tight time constraints, and in the absence of an EPA approved remediation plan for the site.

In conducting its assessment, DOI focused on two categories of economic loss: lost recreational services associated with a trail closure, and the loss in services provided by wetland as a result of the asbestos disposal activities. This case study focuses on the application of the habitat equivalency approach for estimating the economic loss associated with the reduction in services provided by the injured wetland.

DOI determined that 5.58 acres of wetland had been lost from 1968 to the time that the assessment was conducted (1992). While the asbestos dump was created prior to 1968, no estimates of its size were available before 1968. DOI also determined that, following site remediation, approximately seven acres of wetland would be lost in total, due to the need for a cap on the existing asbestos waste pile. DOI assumed that replacement wetland could be established by 1997. That is, five years would be required to create replacement wetland, and thus compensable losses would continue through 1997.

[15] One way to minimize this problem is to shorten the replacement or "payback" period as much as possible. For instance, in the previous example, the number of fish could be increased above 50 per year and the replacement period could be shortened to less than 55 years in order to accelerate the recovery of compensable values.

As shown in Exhibit 4-7, the present value of compensable wetland acre-years lost in this case was 229. To calculate the number of acres of new wetland that would be required, in perpetuity, to compensate the public for these interim losses, DOI applied the following equation:

$$\text{Damages (expressed in wetland acre years)} = (N/0.03)*(1.03)^{-5}$$
$$229 = (N/0.03)*(1.03)^{-5}$$
$$N = (229/)*0.03$$
$$N = 7.96 \text{ acres}$$

Where N equals the number of wetland acres required in perpetuity to compensate the public for past losses.

The first part of this formula (i.e., N/0.03) calculates the number of wetland acres, which if provided from today in perpetuity, would provide an equivalent number of present value wetland acre years to those lost (i.e., 229). In performing this calculation the trustees assumed a three percent discount rate.[16] The second part of this formula (i.e., 1.03^{-5}) accounts for the fact that these replacement acres would not be provided for five years. That is, the estimate of required replacement wetland must be discounted for five years, resulting in the need for additional wetland acreage to make the public whole for waiting for this compensation.[17]

It is important to note that the eight acres of wetland required to compensate the public for interim losses from the time of the release until a replacement wetland was established is separate and distinct from the replacement wetland itself. That is, the responsible party must provide seven acres of *replacement* wetland for that lost due to the site cap, as well as eight additional acres of *compensatory* wetland to make the public whole for the fact that wetland services were lost from 1968 to 1997.

In this case DOI translated compensable damages expressed in terms of wetland acre years into dollars based on the cost of a combination of (1) actions to restore wetlands within the Refuge through the removal of dikes and installation of water control structures, and (2) the cost of purchasing wetlands off the Refuge that were threatened by development. While this case was ultimately presented in bankruptcy court, the court did not rule on whether the habitat equivalency approach was valid in this context. However, the habitat equivalency method has been successfully used in settlement negotiations with responsible parties in a range of cases involving fish populations, bird populations and wetland injury.

[16] The formula used to convert a present value to an equivalent annual value to be paid in perpetuity is PV * i, where PV is the present value and i the discount rate expressed as a fraction.

[17] In this case only 6.84 acres of compensatory wetland would be required if that wetland acreage could have been provided at the time of the claim (i.e., without the five year delay).

Exhibit 4-7

APPLICATION OF THE HABITAT EQUIVALENCY APPROACH TO ESTIMATE COMPENSABLE LOSSES RESULTING FROM INJURY TO WETLANDS IN THE GREAT SWAMP NATIONAL WILDLIFE REFUGE

Year	Wetland Acres Lost	Present Value Calculation	Present Value Wetland Acres Lost
1968	5.58	$* (1 + 0.03)^{(1992-1968)} =$	11.34
1969	5.58	$* (1 + 0.03)^{(1992-1969)} =$	11.01
1970	5.58	$* (1 + 0.03)^{(1992-1970)} =$	10.69
1971	5.58	$* (1 + 0.03)^{(1992-1971)} =$	10.38
1972	5.58	$* (1 + 0.03)^{(1992-1972)} =$	10.08
1973	5.58	$* (1 + 0.03)^{(1992-1973)} =$	9.78
1974	5.58	$* (1 + 0.03)^{(1992-1974)} =$	9.50
1975	5.58	$* (1 + 0.03)^{(1992-1975)} =$	9.22
1976	5.58	$* (1 + 0.03)^{(1992-1976)} =$	8.95
1977	5.58	$* (1 + 0.03)^{(1992-1977)} =$	8.69
1978	5.58	$* (1 + 0.03)^{(1992-1978)} =$	8.44
1979	5.58	$* (1 + 0.03)^{(1992-1979)} =$	8.19
1980	5.58	$* (1 + 0.03)^{(1992-1980)} =$	7.96
1981	5.58	$* (1 + 0.03)^{(1992-1981)} =$	7.72
1982	5.58	$* (1 + 0.03)^{(1992-1982)} =$	7.50
1983	5.58	$* (1 + 0.03)^{(1992-1983)} =$	7.28
1984	5.58	$* (1 + 0.03)^{(1992-1984)} =$	7.07
1985	5.58	$* (1 + 0.03)^{(1992-1985)} =$	6.86
1986	5.58	$* (1 + 0.03)^{(1992-1986)} =$	6.66
1987	5.58	$* (1 + 0.03)^{(1992-1987)} =$	6.47
1988	5.58	$* (1 + 0.03)^{(1992-1988)} =$	6.28
1989	5.58	$* (1 + 0.03)^{(1992-1989)} =$	6.10
1990	5.58	$* (1 + 0.03)^{(1992-1990)} =$	5.92
1991	5.58	$* (1 + 0.03)^{(1992-1991)} =$	5.75
1992	5.58	$* (1 + 0.03)^{(1992-1992)} =$	5.58
1993	5.58	$* (1 + 0.03)^{(1992-1993)} =$	5.42
1994	5.58	$* (1 + 0.03)^{(1992-1994)} =$	5.26
1995	5.58	$* (1 + 0.03)^{(1992-1995)} =$	5.11
1996	5.58	$* (1 + 0.03)^{(1992-1996)} =$	4.96
1997	5.58	$* (1 + 0.03)^{(1992-1997)} =$	4.81
TOTAL			229

4.9 IDENTIFYING AND ADDRESSING DOUBLE-COUNTING

No one method will capture all categories of economic damage resulting from a discharge event. Some methods, however, if applied appropriately, will capture a broad range of economic effects (e.g., contingent valuation and property valuation-based techniques). In cases where more than one method is applied there is the potential for double counting. For example, assume that in the process of conducting a full-scale assessment at a contaminated bay site the trustees undertake both a property valuation study and an assessment of recreational fishing impacts. The damages being estimated using these two approaches could overlap, to the extent that one of the factors influencing home prices around the bay is easy access to a recreational fishing site.[18] In general, the extent to which double counting occurs will depend on the methods used as well as case-specific factors (e.g., the extent of the market for a recreational opportunity).

There are no hard and fast rules for addressing double-counting, other than the application of common sense. In instances where the damages calculated by two (or more) studies are likely to overlap, the trustees may wish to acknowledge the potential overlap by using a range to present the total value of the claim. A more sophisticated approach would be to try and identify and subtract from the total claim the values being counted more than once. For instance, if a hedonic study shows a decrease in property values of $50 million, and a travel cost study shows damages to the recreational fishery of $20 million, the total compensable values can be portrayed as between $50 and $70 million. Alternatively, if the recreational fishing damages can be segregated into "local" and "non-local" components, the property value results could be added to the "non-local" recreational fishing damages to produce a single total compensable values figure.

Finally, in some cases the trustee may wish to intentionally undertake parallel efforts to estimate damages. For example, both a contingent valuation study and a travel cost model might be used to estimate the change in economic value associated with a change in beach quality resulting from a release event. The reason for undertaking parallel studies is to evaluate the "robustness" of the individual study results, or the stability of the final damage estimate given changes in the method used and assumptions made in assessing damages. If the results of parallel studies are substantially similar, the trustees negotiating position will be strengthened.

[18] Another example: if the CV method is utilized to estimate total value (both use and passive use), the application of another technique to estimate use values (e.g., the avoided cost method) will lead to double-counting if the results of these studies are added to estimate total damages.